

U.S. Serial No. 09/543,480
Attorney Docket No. 20004/36

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A system for adding an interference-resistant, inaudible code to an audio signal comprising:

191 a sampler arranged to sample the audio signal at a sampling rate and to generate therefrom a plurality of overlapping short blocks of sampled audio, each of the short blocks having a duration less than a minimum audibly perceivable signal delay;

a processor arranged to combine the plurality of overlapping short blocks into a long block having a predetermined minimum duration;

a frequency transformation arranged to transform the long block into a frequency domain signal comprising a plurality of independently modulatable frequency indices, wherein a frequency difference between two adjacent ones of the indices is determined by the minimum duration and the sampling rate;

a frequency selector arranged to select a neighborhood of frequency indices so that the frequency difference between a lowest index and a highest index within the neighborhood is less than a predetermined value; and,

an encoder arranged to modulate two or more of the indices in the neighborhood so as to make a selected one of the indices an extremum while keeping the total energy of the neighborhood constant.

Claim 2 (original): The system of claim 1 wherein the processor comprises a digital computer having a buffer memory.

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Claim 3 (original): The system of claim 1 wherein the frequency transformation comprises a Fast Fourier Transform algorithm.

Claim 4 (original): The system of claim 1 wherein the encoder comprises an algorithm that increases the energy of a selected index in the neighborhood and that decreases the energy of a short block associated therewith.

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Claim 5 (currently amended): A method of adding a code to a frequency band of a sampled audio portion of a composite signal without thereby introducing a perceptible delay between the encoded audio portion and another portion of the composite signal, the method comprising the steps of:

- a) selecting a sampling rate and a frequency difference between adjacent ones of a predetermined number of frequency indices included in a frequency neighborhood;
- b) determining from the sampling rate and from the frequency difference a duration of a long block of samples;
- c) determining an integral a number of overlapping sequential sub-blocks short blocks to make up the long block, where the integral number is selected so that each of the sub-blocks short blocks has a sub-block duration less than the perceptible delay; and,
- d) processing the long block so as to modulate a selected one of the frequency indices without changing a total signal energy of the band.

Claim 6 (original): The method of claim 5 wherein the composite signal comprises a television broadcast signal and wherein the another portion of the composite signal comprises a video signal.

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Claim 7 (currently amended): The method of claim 5 wherein ~~in step d)~~ the processing the long block comprises modulating two or more of the frequency indices within the neighborhood so as to make a selected one of the indices an extremum.

Claim 8 (currently amended): ~~An apparatus~~ Apparatus for reading a code from an audio signal, ~~the code comprising a sequence of blocks having a predetermined number of samples of the audio signal, the code comprising a synchronization block followed by a predetermined number of data blocks, the apparatus comprising:~~

a buffer memory arranged to sequentially hold ~~one of the blocks~~ blocks of samples of the audio signal;

a frequency transformation arranged to transform ~~the one blocks~~ into spectral data spanning a ~~predetermined number of frequency bands, wherein each of the frequency bands comprises a respective neighborhood of frequency indices;~~

a processor arranged to examine a first plurality of predetermined frequency bands in spectral data associated with a first block to determine, for each of the neighborhoods, if [[a respective]] predetermined one of the frequency indices is modulated in the predetermined frequency bands of the first plurality have a predetermined characteristic; and,

a vote determiner arranged to determine that the first one block is the a synchronization block if [[, in]] the predetermined frequency indices of a majority of the predetermined frequency bands in the first plurality have the predetermined characteristic, the respective modulated-frequency index is a respective index selected for inclusion in the synchronization block;

wherein the processor is further arranged to examine a second plurality of predetermined frequency bands in spectral data associated with a second block to determine if, in one of the data blocks received subsequent to the synchronization block, a respective

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~~predetermined one of the frequency indices is modulated if the frequency indices in the
predetermined frequency bands of the second plurality match one of a set of patterns;~~

~~wherein the vote determiner is further arranged to determine if, in a majority of the
frequency bands, the respective modulated frequency index is a respective index selected for
inclusion in the one data block; identify a code from the second block if a majority of the
second plurality of frequency bands associated with the second block have frequency indices
that match a same pattern.~~

Claim 9 (original): The apparatus of claim 8 wherein the frequency transformation
comprises a Fast Fourier Transform algorithm executed by a digital computer.

Claim 10 (original): The apparatus of claim 8 wherein the processor comprises a
general purpose digital computer operating under program control and having a plurality of
algorithms stored in a memory.

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Claim 11 (currently amended): The apparatus of claim 8 wherein the vote determiner
comprises an algorithm software executed by a digital computer.

Claim 12 (cancelled)

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Claim 13 (currently amended): The method of claim [[12]] 37 wherein a value of k is
read as the code bit in step e) if the a k^{th} index in each a majority of the bands is modulated
match.

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Claim 14 (currently amended): The method of claim [[12]] 37 wherein the ~~predetermined index pattern comprises a~~ patterns comprise pseudo-random sequence sequences.

Claim 15 (currently amended): A system for adding an inaudible code to a tone-like audio portion of a composite signal having two or more portions, the system comprising:


- a sampling apparatus arranged to sample audio at a sampling rate and to generate therefrom a plurality of overlapping short blocks of sampled audio, each of the short blocks having a duration less than a minimum audibly perceptible signal delay;
- a processor arranged to combine the plurality of overlapping short blocks into a long block having a predetermined minimum duration;
- a frequency transformation arranged to transform the long block into a frequency domain signal comprising a plurality of independently modulatable frequency indices located in a plurality of frequency bands;
- an encoder arranged to modulate two or more of the indices in each of the frequency bands so as to make a respective selected one of the indices an extremum while keeping a total acoustic energy of the audio constant;
- a signal analyzer arranged to determine if the tone-like audio portion has a tone-like character within any one of the predetermined number of neighborhoods; and,
- an encoder suspender arranged to suspend the encoding of the encoder within any neighborhood in which the tone-like audio portion has a tone-like character.

Claim 16 (original): The system of claim 15 wherein the audio signal is part of a television broadcast signal.

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Claim 17 (original): The system of claim 15 wherein the frequency transformation comprises a Fast Fourier Transform algorithm.

Claim 18 (original): The system of claim 16 wherein the signal analyzer comprises a computer arranged to carry out a masking algorithm described in ISO/IEC 13818-7:1997.

 Claim 19 (currently amended): A method for adding an inaudible code to at least one of a predetermined number of frequency neighborhoods within a tone-like audio portion of a composite signal having one or more additional portions, the method comprising the steps of:

- a) sampling the audio portion and generating from the sampled signal a plurality of overlapping short blocks, each of the short blocks having a duration less than a minimum audibly perceptible signal delay;
- b) combining the plurality of overlapping short blocks into a long block having a predetermined minimum duration;
- c) transforming the long block into a frequency domain signal comprising a plurality of independently modulatable frequency indices;
- d) identifying those neighborhoods, if any, of the predetermined number of frequency neighborhoods in which the tone-like audio portion has a tone-like character; and,
- e) modulating a respective index in each neighborhood not identified in [[step]] d) so as to make a selected index in such neighborhood an extremum while keeping the total acoustic energy of the audio portion constant, and not modulating an index in any of those neighborhoods identified in [[step]] d).

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Claim 20 (original): The method of claim 19 wherein the composite signal comprises a television broadcast signal and wherein one of the additional portions comprises a video signal.

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Claim 21 (currently amended): The method of claim 19 wherein ~~step e)~~ transforming the long block comprises ~~the step of~~ transforming the long block according to a Fast Fourier Transform.

Claim 22 (currently amended): The method of claim 19 wherein ~~step e)~~ transforming the long block comprises a sub-step of carrying out a masking algorithm described in ISO/IEC 13818-7:1997.

Claim 23 (currently amended): A broadcast audience measurement system in which an inaudible code added to an audio signal is read by a decoding apparatus located within a statistically sampled dwelling, the system comprising:

an encoder arranged to add a predetermined code bit to each frequency band in of a predetermined ~~number~~ plurality of ~~odd~~ frequency bands within a bandwidth of the audio signal;

a receiver within the dwelling arranged to receive the encoded audio portion; and
a decoder ~~having an input from the receiver, the decoder~~ arranged to acquire a respective test value ~~of the code bit~~ from each of the frequency bands in the predetermined plurality of frequency bands, to compare the acquired test values, to determine that one of the test values is the code bit only if ~~that~~ the one of the test value values is acquired from a majority of the frequency bands in the predetermined plurality of frequency bands, and to otherwise determine that none of the acquired test values is the ~~no code bit has been read~~.

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Claim 24 (original): The broadcast audience measurement system of claim 23 wherein the audio signal is part of a television broadcast signal.

Claim 25 (original): The broadcast audience measurement system of claim 23 wherein the receiver includes a microphone.

Claim 26 (original): The broadcast audience measurement system of claim 23 wherein the receiver comprises an audio output jack.

Claim 27 (currently amended): A broadcast audience measurement system in which an inaudible code added to an audio signal is read within a statistically sampled dwelling unit, the system comprising:

an encoding apparatus arranged to add a code bit to a sampled long block of the audio signal, the long block comprising a predetermined number of overlapping short blocks, each of the short blocks having a predetermined duration that is selected to be short enough not to be perceptible to a member of a broadcast audience, the encoding apparatus being further arranged to modulate a selected frequency index in each of a plurality of frequency neighborhoods so as to make each selected index an extremum in the respective neighborhood thereof while keeping a total energy of the audio signal constant;

a receiver within the dwelling, the receiver being arranged to acquire the encoded audio signal; and,

a decoder arranged to read the code from the audio signal, the decoder having an input from the receiver, the decoder comprising a buffer memory arranged to store one of the short blocks, the buffer memory being arranged to store a long block.

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Claim 28 (original): The broadcast audience system of claim 27 wherein the audio signal is part of a television signal.

Claim 29 (original): The broadcast audience system of claim 27 wherein the encoder comprises a frequency transformation arranged to transform the long block into a frequency domain signal.

Claim 30 (original): The broadcast audience system of claim 27 wherein the receiver comprises a microphone.

Claim 31 (original): The broadcast audience system of claim 27 wherein the receiver comprises an audio output jack.

Claim 32 (currently amended): A method of encoding an audio signal comprising the following steps:

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- a) generating a plurality of overlapping short blocks from the audio signal, wherein each of the short blocks has a duration less than a minimum audibly perceivable signal delay;
 - b) combining the plurality of overlapping short blocks into a long block;
 - c) transforming the long block into a spectrum comprising a plurality of independently modulatable frequency indices; and,
 - d) modulating at least two of the indices so as to make one of the indices an extremum while keeping the total energy of a neighborhood of the modulated indices substantially constant.

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Claim 33 (original): A method of reading a code element from an audio signal comprising the following steps:

- a) transforming at least a portion of the audio signal into spectral data spanning a predetermined number of frequency bands having a plurality of frequency neighborhoods;
- b) determining, for each of the neighborhoods, if one of the frequency indices is modulated; and,
- c) assigning a transmitted code value to the code element if, in a majority of the neighborhoods, the respective modulated frequency index is an index selected for inclusion in the audio signal.

Claim 34 (new): An apparatus as defined in claim 8 wherein the first plurality and the second plurality contain the same frequency bands.

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Claim 35 (new): An apparatus as defined in claim 8 wherein the code is a binary number.

Claim 36 (new): An apparatus as defined in claim 35 wherein the binary number is represented by a position of an index having a predefined characteristic in a majority of the bands of the second plurality.

Claim 37 (new): A method of reading a code from an audio signal comprising:

- a) examining a first plurality of predetermined frequency bands in spectral data associated with a first block to determine if predetermined frequency indices in the predetermined frequency bands of the first plurality have a predetermined characteristic;

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b) determining that the first block is a synchronization block if the predetermined frequency indices of a majority of the predetermined frequency bands in the first plurality have the predetermined characteristic;

c) repeating a)-b) with another block if the predetermined frequency indices of a majority of the predetermined frequency bands in the first plurality have the predetermined characteristic;

d) examining a second plurality of predetermined frequency bands in spectral data associated with a second block to determine if the frequency indices in the predetermined frequency bands of the second plurality match one of a set of patterns;

e) identifying a code from the second block if a majority of the second plurality of frequency bands associated with the second block have frequency indices that match a same pattern.

Claim 38 (new): A method as defined in claim 37 wherein each of the patterns is uniquely associated with a respective code bit.

Claim 39 (new): A method of reading a code from an audio signal comprising:
acquiring a test value from each frequency band in a predetermined plurality of frequency bands associated with the audio signal;
comparing the acquired test values;
determining that one of the test values is a code only if the one of the test values is acquired from a majority of the frequency bands in the predetermined plurality of frequency bands; and

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determining that none of the acquired test values is the code if none of the test values
is acquired from a majority of the frequency bands in the predetermined plurality of
frequency bands.